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NIC #15167
Packet Radio Temporary Note 34

R. J. McGuire (Collins)
19 March 1973

PACKET RADIO MEETING, March 1-2, 1973

1.0 INTRODUCTION

This note is a brief outline of the topics discussed in the Packet Radio Meeting, March 1-2, 1973. I have attempted to summarize those conclusions which I felt were generally agreed upon by the group.

1.1 March 1, 1973

The meeting opened with a discussion of the Packet Radio Issues outlined in Temporary Note #20, published by Dr. R. E. Kahn. These issues are:

1. Environment
2. Concept of Repeaters and Stations
3. Packet Sizes and Efficiency
4. Philosophies of Traffic Control - Slotting
5. Interaction of Repeaters

Other issues were raised by NAC and incorporated into the overall discussion. (See Summary of Current NAC Packet Radio Activities, Feb. 28, 1973).

1.1.1 Environmental Conclusions

1.1.2 Terminal design must remain the same regardless of environment. Terminal design will employ Omni Antennas.

1.1.3 Initial Packet Radio design shall be suitable for deployment in residential areas. Areas with large multipath will be avoided initially.

1.2 Concept of Repeaters and Stations

1.2.1 Traffic Objectives - The initial design objective for Packet

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1.2 Concept of Repeaters and Stations

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Radio is to support global communications from the radio network into the ARPA net and back.

1.2.2 Concept of Station

a) Gateway to ARPA net and other networks

b) Directories, used for traffic routing, may be a principal issue when considering the requirement for stations.

1.2.3 Concept of Repeater

a) Communication functions same as stations.

b) Repeater design must consider traffic to multiple gateways. We don't want a repeater design which restricts this.

c) Repeater prototype design will provide computational capabilities. The notion of distributed directories can, therefore, be analyzed without major impact to the network design.

1.3 Packet Sizes and Efficiency

1.3.1 System Parameters were introduced by Dr. Kahn.

These are:

a) Packet Size - The design should strive for reasonable size overhead. The design objective is to provide a format having an efficiency of say 75% for packet sizes of 200 bits and more.

b) Delay - The end-to-end delay on the ARPA net is on the order of 0.2 second. A design objective for Packet Radio is 0.1 second at each end.

c) Reliability - Involves packet error rates and circuit availability. The design objective is 98% overall availability. Local network availability is the same as that provided for long haul.

d) Throughput - Host - IMP throughputs up to 100 KBS is provided on the ARPA net. The design objective for Packet Radio is to provide a throughput in the range of 100 KBS. We should also investigate techniques for increasing the throughput to 1500 KBS.

e) Target Costs - Equipment costs for a repeater concentrating 1 KBS traffic should not exceed $20K. Much lower costs are,

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of course, preferred.

1.4 Philosophies of Traffic Control - Slotting

1.4.1 Packet Radio requirements dictate that the network operate with terminals and repeaters having omni antennas for repeater-terminal traffic. This does not preclude the use of directional antennas in the network for an isolated user, or later consideration of directional antennas.

1.4.2 The built-in inefficiency of carrier detection for packet sensing was discussed. (See para. 4 of PR Temporary Note #20.)

1.4.3 Packet Radio Temporary Note #24 was discussed by F. Tobagi. It was concluded that channel utilization (throughput) is very sensitive to the propagation delay between any pair of devices.

1.5 Interaction of Repeaters

1.5.1 Repeater-Repeater traffic should be accomplished on a basis which does not interfere with the throughput between terminals and their repeater. This can be accomplished using multiple frequencies and omni antennas or a single frequency and directional or steerable antennas.

1.5.2 Omni vs. directional antenna issues

1. Interference
2. Transmitter Power
3. Multipath
4. Channel Capacity

2.0 March 2, 1973

The following issues were discussed:

1. Security
2. Power Level for Repeater
3. Evolution
4. Frequency Band
5. Error Correction
6. Synchronization

2.1 Evolution

2.1.1 The initial prototype will probably consist of 1 repeater and a

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few terminals. The repeater location should be "elevated."

2.1.2 System conceptual design should be finished by summer, 1973.
Hardware design complete by Jan. 1, 1974.
Test system deployment in spring or summer of 1974.

2.1.3 The system will soon evolve to perhaps 12 terminals and up to 4 repeaters. The concept of multiple gateways will be tested.

2.1.4 Tests will be designed and instrumentation provided to determine network dimensionality and failure modes.

2.2 Security

2.2.1 Security issues are to be considered separately from the Packet Radio Group.

2.3 Power Level for Repeaters

2.3.1 Communication requirements will determine the area and define the natural boundaries for the Packet Radio System. SRI and Collins will direct their studies toward defining these boundaries.

2.3.2 Radio part of stations and repeaters should be identical. Synchronization may alter this, however.

2.3.3 Terminal radios will be identical.

2.3.4 The isolated terminal operating in 1-4 GHZ ranges is a major issue. Battery power must be provided for the isolated terminal which typically may have the following operational characteristics:

a) Operating duty cycle: 1-5%
b) Extended periods (10 hrs.) in which it may not operate
c) Throughput: 1 KBS out of 100 KBS.

ARPA now employs Lithium Sulfide batteries which deliver large energy levels in compact package sizes. Dr. Kahn will supply additional information concerning these batteries.

2.4 Frequency Band

2.4.1 It was concluded that frequencies in the 1-4 GHZ range offered an attractive compromise between power efficiencies and spectrum

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availability and will be the initial choice. There is concern regarding availability of UHF frequencies. Many propagational and environmental tests can be made using the frequency allocations of Aloha as well as at 1 GHZ. The results of these tests can be extrapolated to other frequencies. SRI, University of Hawaii, and Collins will work jointly in these areas.

2.5 Error Correction and Synchronization

2.5.1 It appears that error correction circuitry in the Packet Radio Net may be a level of complexity which can be avoided.

2.5.2 Repeaters send ACKS!, no NACKS!

2.5.3 Dr. Fralick reviewed his supercurves (Figure 5 of PR Temporary Note #28). It was concluded that range was not particularly sensitive to modulation technique with other parameters fixed. Dr. Fralick suggested QUCPSK as an economic compromise. No objection to this approach was received. It was decided to focus our thinking toward Spread Spectrum for Packet Radio. The subject of PRN sequences vs. chirp and the degree of spread is to be investigated.

3.0 CATV

The use of a CATV facility for Packet Radio was discussed by Dr. Howard Frank. Because of the limited frequency bands, a spread spectrum modulation may introduce a new level of complexity into the CATV system, since the CATV cable must accomodate the terminal design. It was felt that data line jacks, provided on the terminal, could provide unmodulated signals for CATV use.

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